EEDI: Verification

Perspective from a Verifier

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Outline

- Introduction
- Verification process
  - Model basin qualification
  - Model test witnessing
  - Sea trials
  - EEDI calculation
- Conclusions

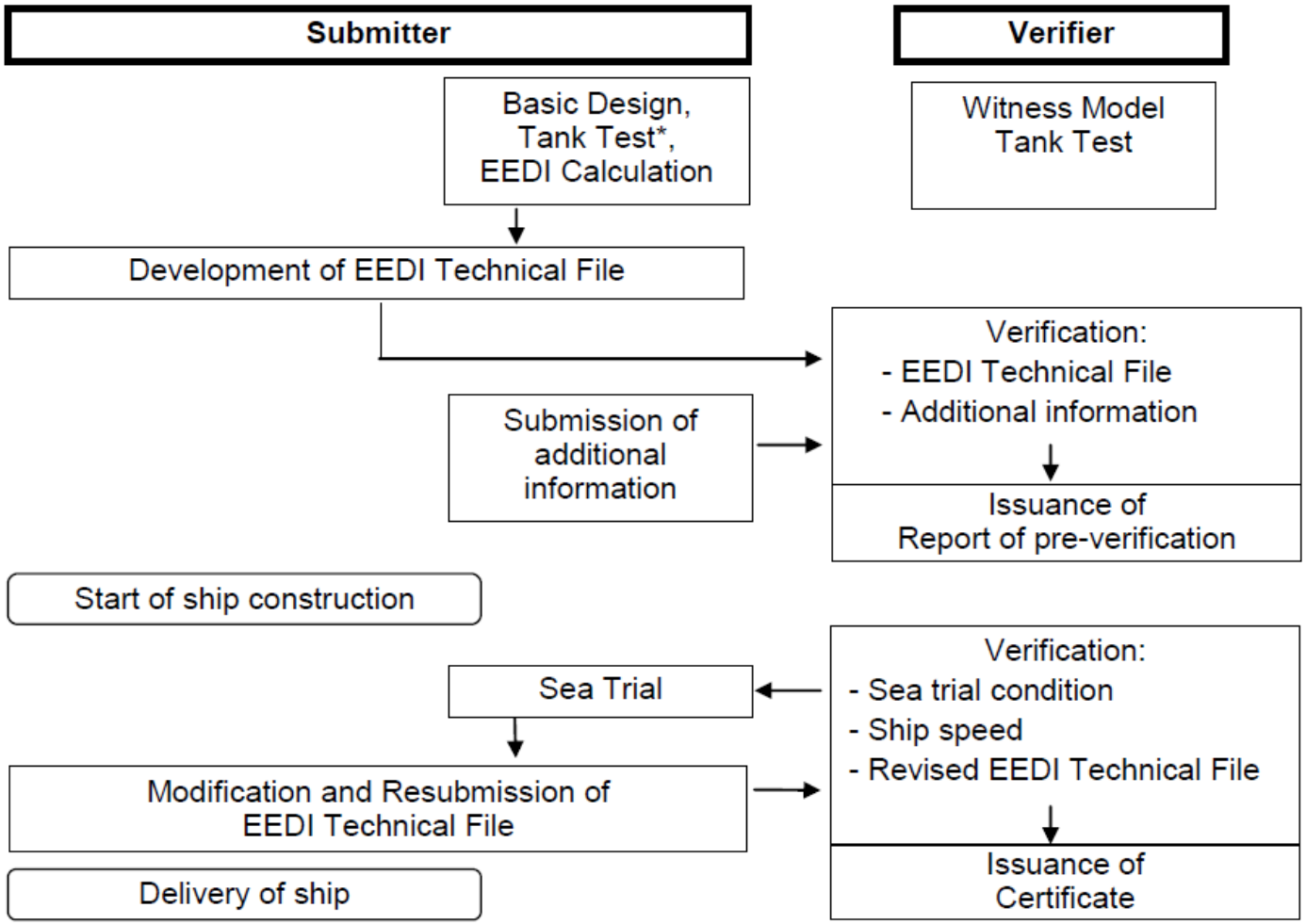
EEDI Applicable Ship Types

- Attained EEDI to be calculated for 12 ship types
  - EEDI not applicable to ships fitted with steam, diesel-electric, hybrid propulsion systems (except LNG carriers, cruise passengerships)
- Attained EEDI ≤ Required EEDI
- Required EEDI (EEDI Phase-dependent) – derived from Reference EEDI by means of reduction factor
- Reference EEDI – defined by regression lines (EEDI vs. DWT)

12 Ship Types

1) **Bulk carrier**
2) **Tanker**
3) **Gas tanker (other than LNG carrier)**
4) **LNG carrier**
5) **Containership**
6) **General cargo ship**
7) **Refrigerated cargo ship**
8) **Combination carrier**
9) **Ro-Ro cargo ship**
10) **Ro-Ro cargo ship (vehicle carrier)**
11) **Ro-Ro passenger ship**
12) **Cruise passengership**

Overview of EEDI Verification



* To be conducted by a test organization or a submitter itself.

[Source: MEPC.1/Circ.816]

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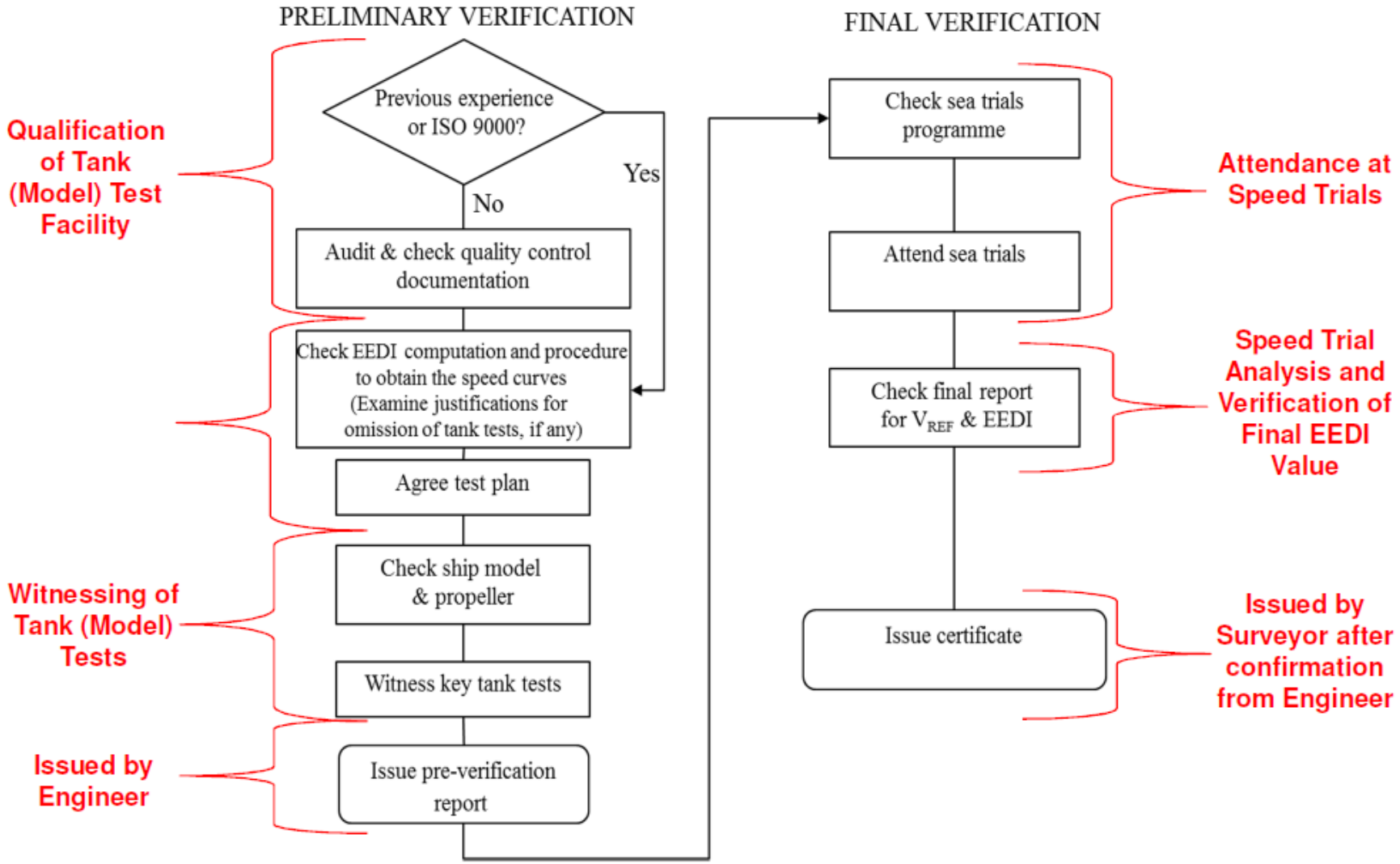
Verification Process: Flowchart of Verifier Tasks



[Source: IACS PR38]

Class-related EEDI Activities

- Qualification of Tank Test Facilities
- Witnessing of Tank Tests
- Preliminary EEDI Verification
- Sea Trials
- Final EEDI Verification, including independent speed trial analysis
- Minimum Propulsion Powering Verification

What Needs to be Verified?

- All the parameters used in the EEDI calculation
- Verification of parameters is straight-forward, except verification of ship speed V_{ref}

$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{n} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}**\right)}{f_i \cdot f_c \cdot Capacity \cdot f_v \cdot V_{ref}}$$

V_{ref}

- V_{ref} – speed at 75% MCR and at EEDI draft (100% DWT; 70% DWT draft for containerships)
  - Model tests are essential:
    - Sea trials often not conducted at EEDI draft
    - V_{ref} to be derived from model test results at sea trial and EEDI draft

Qualification of Tank Test Facilities

- Performed by ABS personnel
- Tasks include:
  - Review of Facility's Quality System, including quality system certificate and quality manual.
  - Review of tank test procedures and model test equipment calibration record
    - Turbulence stimulation method, tolerance of manufacture
  - Review of calculation procedure for ship speed, including estimation basis of model-ship correlation factor
  - Identify and document deviations in the Facility's procedures from International Towing Tank Conference (ITTC) standards
    - Full-scale performance prediction method used and deviations from recommended 1978 ITTC method
- An ABS document "Towing Tank Test Facility Qualification" is issued

Tank (Model) Tests: Witnessing per IMO & IACS PR 38

- Pre-witnessing tasks:
  - Confirmation of Facility's Qualification
  - Review of tank test plan to verify:
    - Proposed loading and speed conditions
    - Sea trial and EEDI draft
- Witnessing tasks:
  - Verification of hull and propeller models
    - Final design of hull, appendages and propeller to be used
  - Review of the status of test equipment calibration
  - Verify loading conditions of model
  - Monitor each run, and flag any peculiar runs to discuss with test team
    - Propeller Open Water
    - Resistance
    - Self propulsion
- Post-witnessing tasks:
  - Review of tank test results (incl. full scale predictions)
  - Issue a "Statement of Witnessing".

Information Required for Tank Test Witnessing

Following are required for verification of performance prediction:

- POW test results, model and full scale
- Towed Resistance test results, model and full scale
- Self-Propulsion tests, model and full scale:
  - Load variation test at sea trial draft (for evaluation of sea trials)
    - Verify same model test loading condition as in sea trials
- Extrapolation procedure followed by the facility, experience-based factors
  - correlation allowance for each draft
  - form factor for each draft
  - CN and CP factors
  - For tests with energy saving devices (ESD), data according to ITTC for both “with and without ESD” as necessary for scaling

Tank Tests Witnessed by Other Class Society

- IACS Procedural Requirement No. 38 is being revised to clarify the procedure for accepting witnessing tasks performed by another IACS member
- This situation generally occurs when the lead vessel in a series is classed with another society, but a sister ship is classed with ABS
- ABS currently requires that the following be submitted in order to accept witnessing by another society:
  - Statement of Witnessing from witnessing class society
  - Pre-verification report of the towing tank tested ship issued by the witnessing society
  - Final towing tank test report
  - Submitter (usually shipyard) to authorize witnessing society to release any additional relevant information held that is requested by the verifying society

Class related EEDI activities

- Qualification of Tank Test Facilities
- Witnessing of Tank Tests
- Preliminary EEDI Verification
  - Verification of calculations
- Sea Trials
- Final EEDI Verification
  - Verification of calculations
  - Minimum Propulsion Powering Verification
  - Issuance of IEEC

Speed Trial Verification

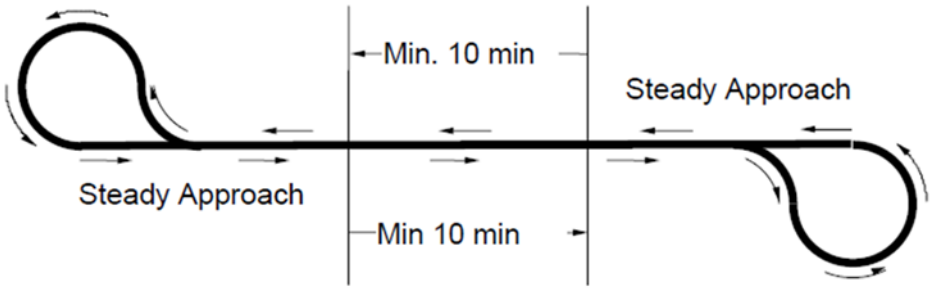
- Shipyard submits EEDI speed trial plan for verifier review
  - Instrumentation
  - Hull and propeller survey
  - Measurement procedures
  - Vessel loading condition, power settings
  - Sea trial area, limiting conditions
- Verifier witnesses EEDI sea trials
- Verifier reviews sea trial report and sea trial analysis
- Verifier reviews derivation of speed V_{ref} at EEDI draft

Key References:

- **IMO Res MEPC 214/(63) – 2012 guidelines for EEDI survey and certification (2014 version to be issued)**
- **ISO 15016:2002 Guidelines for the assessment of speed and power performance by analysis of sea trial data (undergoing revision)**
- **ISO 19019:2005 Instructions for planning, carrying out and reporting sea trials**
- **ITTC Recommended Practices**
  - **7.5-04-01-01. Pt1 – Speed and power trial, preparation and conduct**
  - **7.5-04-01-01.2 Pt2 – Speed and power trial, analysis of speed/power trial data**
- **MARIN – Recommended practice for speed trials (STA) 2006**

Conducting Speed Trials

Double runs: conducted over same ground area

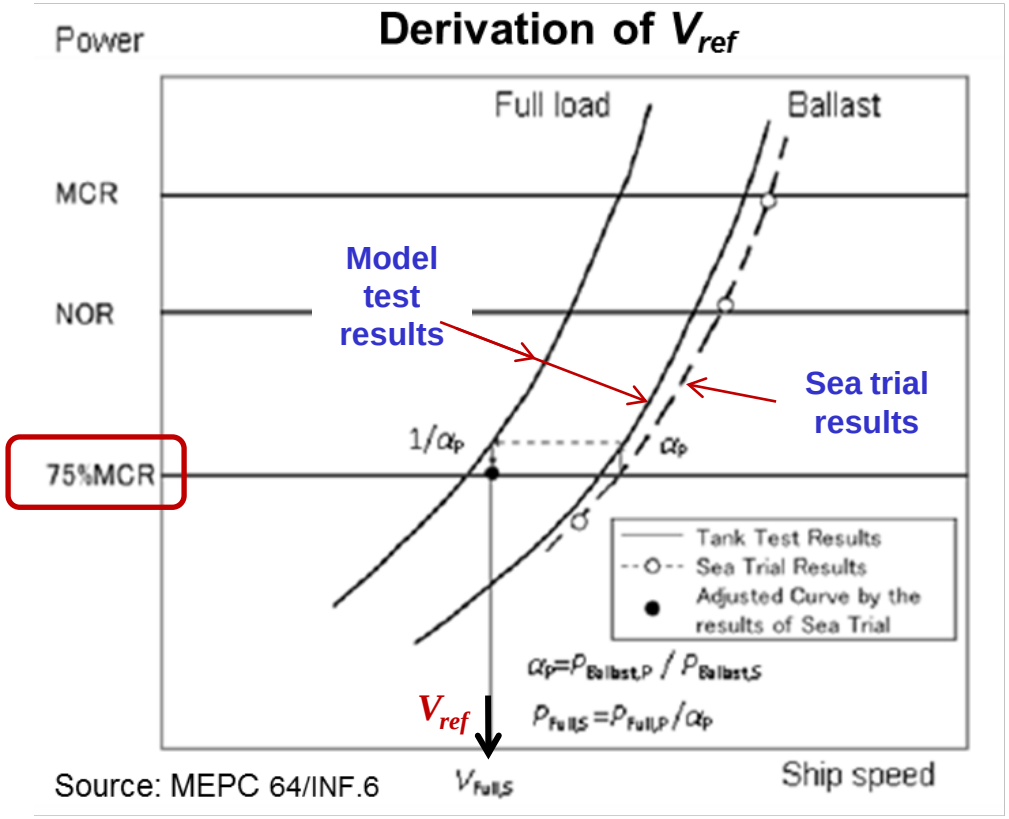


- **ISO 15016:2002**
  - **≥ 3 double runs**
- **ISO 19019:2005**
  - **Run length 5~10 minutes or between 1~ 2 miles**
- **ITTC 7.5-04-01-01.1 2005**
  - **≥ 3 double runs, each at different engine setting**
  - **Time for each run ≥10 min.**

ITTC 7.5-04-01-01.1 2012 Rev.1

- **Time for each run ≥10 min.**
- **5 double-runs at 3 different power settings:**
  - **2 at contract power; 2 at 75% MCR; 1 at power settings between 65% and 100% MCR**
- **For each sister ship of a series: 3 double-runs**
  - **1 at contract power; 1 at 75% MCR; 1 at between 65% and 100% MCR**

Derive V_{ref}



ITTC Procedure

EEDI Reference Speed Verification Tool: STAIMO

- Background to STAIMO
  - Tool developed by MARIN – “Speed Trial Analysis IMO”
  - Incorporates IMO/ITTC guidelines and complies with ITTC 7.5-04-01-01.2
  - Provides final speed versus power curve for EEDI and contract conditions
- Objective of Certification – to confirm that tool is:
  - Compliant with ITTC Guidelines for speed/power trials
  - Consistent and unambiguous
  - Subject to adequate version and update control
  - Offering a reliable authenticity check
- Certified by ABS
  - Speed trial requirements – double-runs, power settings, run duration,
  - Model test data: conversion from speed trial draft to EEDI draft
  - Correction for WWC, water temp./salinity, water depth
  - Direct power method; RPM correction

Conclusions

- EEDI verification is a formal requirement from IMO
- IACS has developed procedures (PR 38) to ensure compliance with the IMO regulations
- Verification process
  - Qualification of model basins
  - Witnessing of Model tests
  - Witnessing of Sea trials
  - EEDI verification
  - Issuance of IEEC

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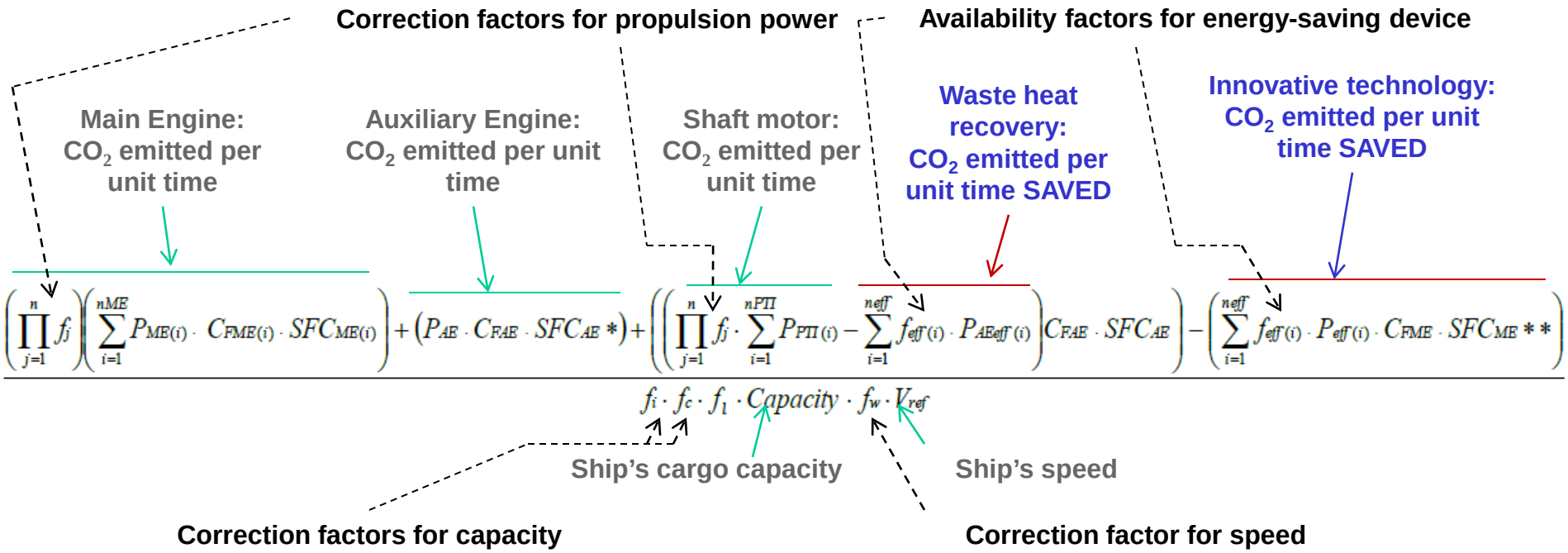
The EEDI Formula



$$EEDI = \frac{CO_2 \text{ emissions per unit time of } \left[\text{main engines + aux engines – WHRS – innovations}\right]}{\text{cargo capacity} \times \text{ship's speed}}$$

EEDI: IMO Documents

- Regulatory text and interpretations
  - First adopted: Res. MEPC 203(62)
  - Unified interpretations:
    - MEPC.1/Circ.795 (12 Oct 2012); amended MEPC 65; amended MEPC 66 (IMO to issue consolidated document)
  - Amendments: MEPC 66, Apr 2014
- Determining minimum installed propulsion power
  - 2013 Interim Guidelines: Res. MEPC 232(65) (17 May 2013)
- SEEMP guidelines
  - 2012 guidelines: Res. MEPC 213(63) (2 Mar 2012)
- EEDI guidelines
  - Method of calculation of EEDI
    - 2012 guidelines: Res. MEPC 212(63) (2 Mar 2012)
    - Amendments to 2012 guidelines: Res. MEPC 224(64) (5 Oct 2012)
    - 2014 guidelines: Res. MEPC… (MEPC 66, Apr 2014)
  - Survey and certification of EEDI
    - 2012 guidelines: Res. MEPC 214(63) (2 Mar 2012)
    - Amendments to 2012 guidelines: Res. MEPC 235(65) (17 May 2013)
    - 2014 guidelines: Res. MEPC… (MEPC 66, Apr 2014)
  - Calculation of EEDI reference line
    - Guidelines: Res. MEPC 215(63) (2 Mar 2012)
    - 2013 guidelines: Res. MEPC 231(65) (17 May 2013)
    - 2013 Guidelines for cruise passenger ships with non-conventional propulsion: MEPC 233(65)